Fall 1999 through Spring 2000

Wisconsin Department of Natural Resources
Bureau of Fisheries Management and Habitat Protection

Root River Steelhead Facility
Fall 1999 through Spring 2000

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Abstract – A total of 6,029 chinook salmon, 1,150 coho salmon, 2,241 steelhead and 131 brown trout were examined at the Root River Steelhead Facility (RRSF) during fall, 1999 and spring, 2000. The majority of the chinook (5,388 or 89%) were passed upstream. The remaining 641 were sacrificed for either disease or contaminant testing, or were too weak to pass. Six hundred twenty-five chinook salmon were spawned to contribute about 800,000 eggs. A total of 978 coho salmon were passed upstream, another 154 were transported to Kettle Moraine Springs Hatchery as broodstock, and the remaining 18 were sacrificed for disease testing, or were too weak to pass. Two hundred sixty-one coho salmon were spawned to produce 150,000 eggs. The fall return of steelhead was again low, at only 70. Fifty skamania-strain steelhead were identified by fin clips and transported along with eight skamania from the Kewaunee River to Kettle Moraine Springs Hatchery as broodstock to produce 182,543 eggs. One steelhead died in the weir, and the remaining 19 were passed upstream. The bulk of the spring steelhead (2,107 fish) were passed upstream; 427 of these were spawned before passage to produce 1,552,476 eggs. The remaining 64 spring steelhead were sacrificed for disease testing or to recover coded wire tags. All 131 brown trout and 6 brook trout were passed upstream. The estimated population of chinook salmon, at 13,836 ($\pm$ 4,088 SD), was more than twice the next-highest year, while coho salmon declined for the second year in a row, to 3,101 ($\pm$ 434 SD). Estimated populations of brown trout and ganaraska steelhead were 750 ($\pm$ 342 SD) and 1,625 ($\pm$ 278 SD), respectively. Very few skamania steelhead were passed upstream, and no recaptures were made for either skamania or chambers creek steelhead.

The Root River Steelhead Facility (RRSF) continues to be a valuable source of fish for both anglers and fishery managers. It is one of three weirs operated by Wisconsin Department of Natural Resources (WDNR) to collect information and broodstock from Lake Michigan trout and salmon. The Strawberry Creek Weir in Sturgeon Bay targets chinook salmon, while the Basadney Area Fishery Facility (BAFF) on the Kewaunee River targets coho salmon and the RRSF contributes primarily steelhead. In addition, BAFF and RRSF provide backup collection sites for the other species. Brown trout do not return well to the weir sites, and are collected in the lower reaches of the rivers with a boat electroshocker. Management of trout and salmon in Lake Michigan brood rivers is intended to ensure adequate egg collections, conserve the genetic diversity of feral trout and salmon stocks and provide fishing opportunities. To accomplish these objectives, weir operations follow strategies outlined by WDNR guiding documents (e.g., Ives 1996, WDNR 1999).

The weirs provide a more efficient and reliable method to collect adult salmonids than the portable weirs and electrofishing efforts employed during past years. The RRSF was constructed in 1994 through a cooperative effort by WDNR, Salmon Unlimited, City of Racine and U.S. Fish & Wildlife Service. In addition to providing a collection and processing site for returning adult salmonids, the RRSF provides a unique educational tool for school groups and other interested publics.

This paper reports the results of data collected at the RRSF during fall, 1999 through spring, 2000. These data contribute to a long-term index of chinook, coho and steelhead populations in the Root River, and are collected to fulfill three objectives: 1) track the abundance of salmonid returns, 2) measure age-specific growth and condition of each species and/or strain, and 3) estimate return rate of each species.

METHODS

During operation of the weir, a minimum of 100 fish per targeted species and fin clip were sampled. These fish were measured to the nearest millimeter, weighed to the nearest 0.1 pound, examined for fin clips, gender and condition. The remaining fish were tallied by species, sex and fin clip. Gametes were stripped from these fish, if needed. After this initial handling, fish were either held for broodstock, passed upstream or sacrificed (fish health or contaminant samples). All fish passed upstream were given an upper caudal clip for population estimates.

All non-target species or fin clips were tallied by species, fin clip and sex, given an upper caudal clip and passed upstream. All coded wire tagged (CWT) fish are marked by an adipose-only clip, and have a tiny microtag implanted in their heads. The CWT fish were measured, weighed and sacrificed; heads were removed from behind the opercular flap, and frozen for later examination. Fish needed for other studies including disease or contaminant samples were frozen for later examination.

Size and condition

Trends in size and condition of all species processed at RRSF are calculated. Only fish with both total length and weight data are included in calculations of 1) average weight, 2) trophy weight (95^{th} percentile of the weight distribution), and 3) standard weight (predicted weight at a given length based on a length-weight regression).

Steelhead strain evaluation

Approximately 33,000 fish per steelhead strain (skamania, chambers creek and ganaraska) are stocked into the Root River annually. All steelhead stocked in the broodstock rivers (Root and Kewaunee Rivers) are marked with a fin clip to identify the strain and yearclass. Each strain is assigned three fin clips (two fin clips prior to 1997), which are rotated annually. In addition to their use in identifying fish for breeding purposes, the fin clips allow each strain to be evaluated. This includes age of returning fish, return rates and population estimates by strain.

Population estimates

Fish that are passed by the weir are marked with a caudal (tail) clip, and recaptures of marked fish are noted in the creel survey for a mark-recapture population estimate of the population above the weir. Population estimates for each species or strain are derived from one of two equations. When sample sizes were adequate, the Petersen equation for mark and recapture was used (Ricker 1975):

$$N = \frac{M * C}{R} \quad (1)$$

Where

N = size of population in the river
M = number of marked fish at large in the river
C = number of recaptured fish
R = number of marked fish in the recapture sample

The sample standard deviation was calculated as:

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R^3}} \quad (2)$$

For species or strains with low sample sizes, the Bailey's modified equation was used for the population estimate (Ricker 1975):

$$N = \frac{M * (C + 1)}{R + 1} \quad (3)$$

With sample standard deviation:

$$S(N) = \sqrt{\frac{M^2 * (C + 1) * (C - R)}{(R + 1)^2 * (R + 2)}} \quad (4)$$

RESULTS AND DISCUSSION

The sixth season of operation for RRSF began September 29, 1999 and concluded March 30, 2000. A total of 6,029 chinook, 1,150 coho, 2,241 steelhead and 131 brown trout were examined (Table 1).

Chinook salmon

A total of 6,022 chinook salmon were examined at RRSF during fall, 1999 (Table 2). Another seven bright silver (i.e., not spawning color) chinook were passed during spring operations. More chinook than past years were sacrificed for contaminant samples (18), disease testing (99), or were too weak to pass (524). The large return of chinook may have caused crowding in the pens and increased mortality. However, the majority (5,388 or 89%) were passed upstream. About 800,000 eggs were collected from 625 chinook.

Average weight of chinook salmon increased to 13.2 pounds, a pound over the 1998 value and the highest over the six-year period of record (Table 3). Standard weight was the second-highest since 1994, while trophy weight was near the median value.

Chinook strain evaluation

The fall, 1999 return of four-year-olds from the 1995 yearclass concluded the evaluation between Lake Ontario strain (LOS) and Lake Michigan strain (LMS) chinook salmon. In all cases, LMS chinook of a given age (return at age 1+ was not evaluated) returned at higher rates than LOS chinook (Table 5). In addition, average lengths and weights of LMS were considerably larger than LOS for both males and females, except during 1998, when age 3+ and 4+ LMS were smaller than similarly-aged LMS from other years and similar to LOS 3+ and 4+ fish. In general, LMS chinook salmon survived better and grew larger than LOS chinook. These results agree with the findings of Peeters and Royseck (1998).

Coho salmon

During September 29 through November 3, 1999, 1,150 coho salmon were examined at RRSF (Table 6). Most coho (978) were passed upstream, constituting 85% of the return. Another 18 were saved for health analysis, and 154 were transferred to a hatchery for spawning. The 150,000 eggs were taken from 261 coho. Age composition (based on length-frequencies) was similar to 1994 through 1996, with 44% age 1+ and 56% age 2+ (Table 7).

Average weight and length, standard weight and trophy weight were all the highest recorded for coho salmon at RRSF (Table 2). This corroborates Lake Michigan creel data, which indicated that coho were exceptionally large and in good condition during 1999, but harvest numbers were down (Kubisiak 2000).

Steelhead

A total of 2,241 steelhead were examined at RRSF from September 29, 1999 to March 30, 2000. Most fish (2,126 or 95%) were passed upstream (Table 9). Fifty skamania-strain steelhead were transported to Kettle Moraine Springs hatchery during late summer and fall and held until ready to spawn. Sixty-five steelhead were sacrificed for disease testing or contaminants samples. The remainder (2,126) were passed upstream.

Egg collections totaled 182,543 skamania, 738,776 chambers creek and 813,700 ganaraska. Combined steelhead-broodstock numbers from the BAFF (Hogler and Surendonk 2001) and RRSF have declined below the target of 200 to 250 pairs per strain (Ives 1996). Egg collections, which should total 500,000 per strain to produce 170,000 yearling steelhead, have been barely adequate as a result, particularly for skamania. Possible factors contributing to this decline may include excessive angler-harvest of adult steelhead, one or more poor yearclasses, poor stream conditions for juveniles or adults, poor condition of returning adults, declining genetic fitness of feral broodstock, or too much passage of fish during periods when the weir is open. These factors and possible solutions are being investigated by Team Nearshore, a group of WDNR fisheries management and hatchery professionals charged to improve nearshore Lake Michigan fisheries.

Steelhead strain evaluation

The percent age composition of the spring and fall runs was assigned from age-length keys developed from known-age (fin clipped) fish, including 46 fall-run and 540 spring-run steelhead. All of the fin-clipped fall steelhead were skamania strain, except one age 3 chambers creek. Age 1 and 2 were not represented in the fall run, age 3+ comprised 32.3%, 4 were 54.7%, 5 were 5.2% and 6 were 7.8% (Table 10). During spring, age 2 represented 8% of the return, 3 were 21.3%, 4 were 53.6%, 5 were 14.2% and 6 were 3.0%. Steelhead returns during fall, 1999 and spring, 2000 appear to be skewed towards age 4 fish, with over 50% of both spring and fall runs contributed by age 4.

All three steelhead strains have been stocked in approximately equal proportions over the last decade (Table 11). Each strain receives a unique fin clip, and fin clips within a strain are rotated on a three-year cycle since 1997. This allows much cleaner separation of yearclasses than the two-year fin clip rotation used previously. All three strains of steelhead returned in the greatest number at age 4. Age-4 skamania females averaging 28.7 inches and 7.8 pounds; males averaged 30.7 inches and 9.2 pounds (Table 12).

Age-4 chambers creek females averaged 28.7 inches and 8.2 pounds; males averaged 30.1inches and 8.5 pounds. Age-4 ganaraska females averaged 27.8 inches and 7.8 pounds; males averaged 29.9 inches and 9.3 pounds (Table 13).

Fall sizes of skamania appear to be larger than spring sizes of other strains (Tables 12 and 13). However, a steelhead advances a year in age from fall to spring, but is unlikely to grow significantly, so it might be more appropriate to compare within yearclasses. For example, age-4 returns during fall, 1999 and age-5 returns during spring, 2000 are both from the 1995 yearclass, and mean lengths and weights did not differ substantially among strains (Tables 12 and 13).

Population estimates

All fish passed upstream of RRSF received a caudal clip for use in a mark-recapture population estimate of trout and salmon in river-reaches upstream of the weir (Table 14). The recapture phase of the estimate uses the creel survey to identify upstream recaptures. A record 13,836 ($\pm$ 4,088 SD) chinook salmon were estimated during 1999. The coho estimate of 3,101 ($\pm$ 434) is the lowest over the six-year period (excluding 1994, when too few were recaptured to generate an estimate). Only 19 skamania were released above the weir and none of these were recaptured, making the estimate of 266 ($\pm$ 181 SD) subject to question. Nevertheless, it provides additional evidence that the skamania return was extremely poor. Too few chambers creek steelhead were encountered to produce an estimate, but the ganaraska estimate of 1,625 ($\pm$ 278 SD) was also very low.

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Table 1. Summary of chinook salmon, coho salmon, steelhead, brown and brook trout captured at the Root River Steelhead Facility during 1994-2000

CHINOOK SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	129	1,726	3	1,858
Fall, 1995	300	2,663	16	2,979
Fall, 1996	62	5,440	87	5,589
Fall, 1997	0	3,974	128	4,102
Fall, 1998	67	3,845	65	3,977
Fall, 1999	221	5,381	420	6,022
Spring, 2000	0	7	0	7

COHO SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	285	513	15	813
Fall, 1995	1,191	2,115	15	3,321
Fall, 1996	161	3,940	305	4,406
Fall, 1997	655	6,909	330	7,894
Fall, 1998	328	3,336	336	4,000
Fall, 1999	154	978	18	1,150

STEELHEAD

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	218	583	47	848
Spring, 1995	120	2,582	18	2,720
Fall, 1995	330	208	0	538
Spring, 1996	150	2,970	49	3,169
Fall, 1996	248	105	0	353
Spring, 1997	2	2,918	125	3,045
Fall, 1997	408	228	8	644
Spring, 1998	0	382	0	382
Fall, 1998	86	64	1	151
Spring, 1999	0	2,131	132	2,263
Fall, 1999	50	19	1	70
Spring, 2000	0	2,107	64	2,171

BROWN TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	0	259	0	259
Fall, 1995	46	645	0	691
Spring, 1996	0	4	0	4
Fall, 1996	70	244	0	314
Spring, 1997	0	2	0	2
Fall, 1997	114	369	3	486
Spring, 1998	0	2	0	2
Fall, 1998	14	202	12	228
Fall, 1999	0	125	0	125
Spring, 2000	0	6	0	6

BROOK TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1994	0	160	0	160
Spring, 1995	0	1	0	1
Fall, 1995	0	6	0	6
Fall, 1996	0	5	0	5
Fall, 1997	0	2	0	2
Fall, 1998	0	1	0	1
Fall, 1999	0	6	0	6

Table 2. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 1999 and spring, 2000.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
29-Sep-99	0	791	197	988
30-Sep-99	0	981	16	997
01-Oct-99	0	70	4	74
04-Oct-99	0	385	0	385
05-Oct-99	147	427	23	597
07-Oct-99	0	666	2	668
08-Oct-99	0	556	3	559
11-Oct-99	74	397	27	498
13-Oct-99	0	302	25	327
15-Oct-99	0	309	7	316
18-Oct-99	0	120	102	222
21-Oct-99	0	172	0	172
02-Nov-99	0	187	14	201
03-Nov-99	0	18	0	18
03-Mar-00	0	0	0	0
08-Mar-00	0	1	0	1
15-Mar-00	0	0	0	0
22-Mar-00	0	3	0	3
30-Mar-00	0	3	0	3
Totals	221	5,388	420	6,029

Table 3. Average weight, average length, standard weight and trophy (95th percentile) weight for the major salmonid species returning to the Root River Steelhead Facility during 1994 to 2000.

Season	Number used in analysis	Average weight (pounds)	Average length (inches)	Standard weight	Trophy weight
CHINOOK SALMON					
1994 – 95	343	8.9 ± 5.3	27.7 ± 5.6	9.7	17.8
1995 – 96	443	12.0 ± 5.9	30.7 ± 5.2	10.1	21.0
1996 – 97	703	11.7 ± 5.7	30.7 ± 5.4	9.8	21.1
1997 – 98	490	12.7 ± 4.9	32.5 ± 4.4	9.5	21.1
1998 – 99	389	12.2 ± 5.0	31.9 ± 4.3	9.5	19.6
1999 – 2000	418	13.2 ± 4.4	32.5 ± 3.8	9.9	19.9
COHO SALMON					
1994 – 95	208	1.5 ± 1.1	15.9 ± 2.5	3.7	3.0
1995 – 96	594	3.1 ± 2.5	19.6 ± 5.1	3.6	9.0
1996 – 97	1,273	5.1 ± 2.4	23.9 ± 4.7	3.5	8.3
1997 – 98	828	3.8 ± 1.7	21.8 ± 3.5	3.5	6.7
1998 – 99	477	4.3 ± 1.7	23.4 ± 3.1	3.4	7.5
1999 – 2000	338	7.1 ± 4.4	25.5 ± 5.9	4.0	13.5
STEELHEAD					
1994 – 95	638	5.9 ± 2.8	25.4 ± 4.7	3.5	10.7
1995 – 96	963	6.2 ± 2.7	25.6 ± 4.3	3.7	11.0
1996 – 97	626	7.2 ± 2.4	27.4 ± 3.3	3.6	11.2
1997 – 98	522	5.8 ± 2.9	25.7 ± 4.9	3.4	11.2
1998 – 99	603	6.2 ± 2.0	25.9 ± 3.3	3.9	9.8
1999 – 2000	767	7.3 ± 2.5	27.2 ± 3.9	3.6	11.0
BROWN TROUT					
1994 – 95	108	4.9 ± 1.5	22.1 ± 2.7	3.4	7.0
1995 – 96	201	5.3 ± 2.2	22.4 ± 3.3	3.6	9.0
1996 – 97	162	4.6 ± 2.1	21.4 ± 4.0	3.4	7.8
1997 – 98	250	6.7 ± 3.4	24.0 ± 3.7	3.8	14.1
1998 – 99	55	6.6 ± 3.2	24.3 ± 3.5	3.5	13.5
1999 – 2000	120	6.7 ± 2.6	23.9 ± 3.7	3.5	10.1

Table 4. Number of chinook salmon stocked in the Root River during 1991 - 1999.

Year stocked	Total number	Strain	Fin clip
1991	174,933	Lake Michigan	None
1992	166,989	Lake Ontario	RMLV
1993	99,345	Lake Michigan	LMRV
	70,000	Lake Ontario	None
1994	75,533	Lake Michigan	LP
	60,000	Lake Michigan	None
1995	99,000	Lake Michigan	RP
	69,250	Lake Michigan	None
1996	158,000	Lake Michigan	None
1997	142,500	Lake Michigan	None
1998	161,500	Lake Michigan	None
1999	143,100	Lake Michigan	None

Table 5. Return rate of chinook salmon at age and strain to the Root River Steelhead Facility during fall, 1994 – 1999. Return rate is expressed as a percent of the number of chinook salmon stocked in the Root River recovered at the Root River Steelhead Facility. Total number of chinook returning to the facility are in parentheses.

	Percent age at return				
	1+	2+	3+	4+	Total return
1992 year class					
[1] L. Ontario (RMLV)	-	0.15 (245)	0.09 (152)	0.01 (17)	0.24 (414)
1993 year class					
L. Michigan (LMRV)	0.33 (323)	0.78 (775)	0.85 (840)	0.06 (68)	2.02 (2,006)
1994 year class					
[2] L. Michigan (LP)	0.10 (73)	0.58 (440)	0.81 (612)	0.04 (43)	1.55 (1,171)
1995 year class					
L. Michigan (RP)	0.19 (189)	0.35 (346)	0.41 (403)	0.03 (35)	0.98 (973)

[1] Total return for the L. Ontario strain chinook salmon from the 1992 year class was calculated only using ages 2-4. Actual total return rate was probably higher for this stocking.
[2] Three chinook from the 1994 year class returned at age 5+.

Table 6. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 1999.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
29-Sep-99	0	46	0	46
30-Sep-99	0	21	0	21
01-Oct-99	0	1	0	1
04-Oct-99	0	69	0	69
05-Oct-99	57	52	1	110
07-Oct-99	50	129	0	179
08-Oct-99	0	110	0	110
11-Oct-99	0	101	1	102
13-Oct-99	0	132	0	132
15-Oct-99	0	95	0	95
18-Oct-99	0	47	0	47
21-Oct-99	0	133	3	136
02-Nov-99	0	2	0	2
03-Nov-99	47	40	13	100
Totals	154	978	18	1,150

Table 7. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility during fall, 1994 - 1999. Age is based on age-length key developed from known aged fin clipped coho salmon, except during 1999, when ages were assigned by length-frequency of measured fish. Total number represents the number of coho salmon used in the analysis.

Year of Return	Percent age composition 1+	2+	Total Number
1994	53	47	780
1995	24	76	3,049
1996	32	68	4,211
1997	5	95	7,699
1998	12	88	4,170
1999	44	56	341

Table 8. Number of coho salmon stocked in the Root River during 1994 - 1999.

Year stocked	Total number	Strain	Fin clip	Age
1994	66,080	Lake Ontario	None	Spring yearling 1+
	55,954	Lake Ontario	RMLP	Fall fingerling 0+
	50,389	Lake Michigan	RP	Spring yearling 1+
1995	65,100	Lake Michigan	RMRP	Spring yearling 1+
	54,832	Lake Michigan	RMLV	Fall fingerling 0+
1996	40,590	Lake Michigan	RMRV	Spring yearling 1+
	63,697	Lake Michigan	LP	Fall fingerling 0+
1997	48,107	Lake Michigan	RP	Spring yearling 1+
	6,668	Lake Michigan	REL	Spring yearling 1+
	4,208	Lake Michigan	None	Spring yearling 1+
	20,604	Lake Michigan	None	Fall fingerling 0+
1998	33,666	Lake Michigan	None	Spring yearling 1+
	10,000	Lake Michigan	None	Fall fingerling 0+
1999	45,945	Lake Michigan	None	Spring yearling 1+
	13,824	Lake Michigan	None	Fall fingerling 0+

Table 9. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 1999 and spring, 2000.

Date	Number harvested	Number passed upstream	Number of miscellaneous Samples	Total number of fish
29-Sep-99	8	0	1	9
30-Sep-99	0	0	0	0
01-Oct-99	0	0	0	0
04-Oct-99	0	2	0	2
05-Oct-99	7	2	0	9
07-Oct-99	11	3	0	14
08-Oct-99	0	2	0	2
11-Oct-99	15	3	0	18
13-Oct-99	0	2	0	2
15-Oct-99	0	2	0	2
18-Oct-99	0	2	0	2
21-Oct-99	9	1	0	10
02-Nov-99	0	0	0	0
03-Nov-99	0	0	0	0
03-Mar-00	0	383	0	383
08-Mar-00	0	559	2	561
15-Mar-00	0	638	60	698
22-Mar-00	0	293	0	293
30-Mar-00	0	234	2	236
Totals	50	2,126	65	2,241

Table 10. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility during 1994 – 2000. Age is based on age-length key developed from known-age fin clipped steelhead. Total number represents the number of steelhead used in the analysis.

Year of return	Percent age composition 1+	2+	3+	4+	5+	6+	7+	Total number
Fall – 1994	8.9	7.5	43.2	34.2	6.2	-	-	146
Spring – 1995		7.3	31.3	38.0	12.7	10.7	-	450
Fall – 1995	15.6	12.2	21.8	49.7	0.7	-	-	147
Spring – 1996		11.0	36.1	33.1	9.1	10.1	0.6	692
Fall – 1996	-	26.3	36.8	5.3	31.6	-	-	21
Spring – 1997		1.0	22.1	42.5	22.5	10.5	1.4	483
Fall – 1997	-	4.4	14.2	67.2	9.6	4.4	-	135
Spring – 1998		15.3	35.9	37.6	5.6	5.2	0.4	287
Fall – 1998	-	-	29.3	44.0	25.3	1.4	-	75
Spring – 1999		2.1	46.5	44.2	7.3	-	-	385
Fall – 1999	-	-	32.3	54.7	5.2	7.8	-	51
Spring – 2000		8.0	21.3	53.6	14.2	3.0	-	714

Table 11. Summary of steelhead stocking numbers by strain and fin clip in the Root River during 1994 through 1999.

Year stocked	Total number	Strain	Fin clip
1994	30,417	Skamania	RM
	35,124	Chambers Creek	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Creek	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Creek	LM
	35,404	Ganaraska	ARV
1997	35,262	Skamania	RMRV
	35,024	Chambers Creek	LMLV
	35,201	Ganaraska	BV
1998	37,484	Skamania	ARM
	33,187	Chambers Creek	ALM
	33,548	Ganaraska	ALV
1999	35,528	Skamania	RM
	26,951	Chambers Creek	LM
	26,963	Ganaraska	ARV

Table 12. Average length and weight at age (± 1 standard deviation) of fin-clipped skamania steelhead examined at the Root River Steelhead Facility during fall, 1999.

Sex		Age 3+	Age 4+	Age 5+	Age 6+
Female	Average length	27.9	28.7	30.1	31.9
		(± 1.3 in)	(± 1.0 in)	(± 0 in)	(± 0.7 in)
	Average weight	7.3	7.8	10.3	9.0
		(± 0.7 lb.)	(± 1.1 lb.)	(± 0 lb.)	(± 0.1 lb.)
	Observations	9	21	1	2
Male	Average length	29.1	30.7	33.1	32.5
		(± 2.1 in)	(± 0.8 in)	(± 0 in)	(± 0.3 in)
	Average weight	7.3	9.2	10.9	10.9
		(± 1.0 lb.)	(± 0.6 lb.)	(± 0 lb.)	(± 0.2 lb.)
	Observations	5	4	1	2

Table 13. Average length and weight at age (± 1 standard deviation) of fin-clipped steelhead examined at the Root River Steelhead Facility during spring, 2000.

Strain and sex		Age 2+	Age 3+	Age 4+	Age 5+	Age 6+
Chambers Cr.	Average length		25.3	28.7	29.5	30.4
Female			(± 1.5 in)	(± 1.4 in)	(± 1.9 in)	(± 2.0in)
	Average weight		6.1	8.2	8.7	9.1
			(± 1.0 lb.)	(± 1.4 lb.)	(± 1.7 lb.)	(± 2.0 lb.)
	Observations	0	15	53	37	5
Chambers Cr.	Average length	17.2	27.3	30.1	30.5	30.2
Male		(± 1.1 in)	(± 1.7 in)	(± 2.1 in)	(± 2.7 in)	(± 0.1 in)
	Average weight	1.6	6.5	8.5	8.7	7.8
		(± 0.3 lb.)	(± 1.3 lb.)	(± 1.5 lb.)	(± 2.2 lb.)	(± 1.7 lb.)
	Observations	12	11	37	17	3
Ganaraska	Average length	17.1	25.2	27.8	28.5	30.2
Female		(± 0 in)	(± 2.2 in)	(± 1.6 in)	(± 2.1 in)	(± 0.2 in)
	Average weight	1.9	5.8	7.8	8.4	9.1
		(± 0 lb.)	(± 1.6 lb.)	(± 1.5 lb.)	(± 1.9 lb.)	(± 0.8 lb.)
	Observations	1	55	129	15	2
Ganaraska	Average length	16.7	24.7	29.9	27.0	30.1
Male		(± 1.6 in)	(± 2.7 in)	(± 2.1 in)	(± 3.3 in)	(± 0.3 in)
	Average weight	1.6	5.4	9.3	7.6	9.8
		(± 0.4 lb.)	(± 1.7 lb.)	(± 2.0 lb.)	(± 3.3 lb.)	(± 0.3 lb.)
	Observations	35	19	73	3	2
Skamania	Average length		24.2	27.6	28.3	28.4
Female			(± 0 in)	(± 1.3 in)	(± 1.1 in)	(± 0.7 in)
	Average weight		5.4	6.6	7.7	7.5
			(± 0 lb.)	(± 0.8 lb.)	(± 0.9 lb.)	(± 0.5 lb.)
	Observations	0	1	3	5	2
Skamania	Average length		21.5		31.7	31.9
Male			(± 6.3 in)		(± 0 in)	(± 0.8 in)
	Average weight		3.9		9.6	10.0
			(± 3.1 lb.)		(± 0 lb.)	(± 1.3 lb.)
	Observations	0	1	0	1	2

Table 14. Population estimates for chinook, coho and steelhead salmon returning to the Root River during fall, 1994 through spring, 2000.

Year and species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (±) 1 SD
Fall 1994				
Chinook	1,720	143	44	5,590 ± 701
Coho	513	2	0	-
Skamania	556	22	6	1,827 ± 539
Spring 1995				
Chambers Creek	1,653	117	45	4,298 ± 503
Ganaraska	453	74	11	2,718 ± 691
Fall 1995				
Chinook	2,663	36	21	4,478 ± 594
Coho	1,354	33	13	3,288 ± 651
Skamania	482	36	6	2,547 ± 811
Spring 1996				
Chambers Creek	1,045	48	28	1,765 ± 206
Ganaraska	1,457	77	31	3,551 ± 475
Fall 1996				
Chinook	5,440	37	36	5,587 ± 147
Coho	3,940	9	9	3,940 ± 0
Skamania	105	29	0	3,150 ± 2,189
Spring 1997				
Chambers Creek	900	38	6	5,014 ± 1,606
Ganaraska	139	23	5	5,356 ± 1,753
Fall 1997				
Chinook	3,974	40	31	5,127 ± 436
Coho	6,909	52	45	7,983 ± 436
Skamania	228	16	2	1,297 ± 509
Spring 1998				
Chambers Creek	93	15	2	501 ± 226
Ganaraska	217	17	1	1,962 ± 1,067
Fall 1998				
Chinook	3,845	55	51	4,146 ± 156
Coho	3,336	25	19	4,389 ± 493
Skamania	64	33	1	1,088 ± 609
Brown	202	31	11	539 ± 118
Spring 1999				
Chambers Creek	678	-	-	-
Ganaraska	1,043	-	-	-
Fall 1999				
Chinook	5,381	18	7	13,836 ± 4,088
Coho	978	111	35	3,101 ± 434
Skamania	19	13	0	266 ± 181
Brown	125	17	2	750 ± 342
Spring 2000				
Chambers Creek	460	1	0	-
Ganaraska	1,006	21	13	1,625 ± 278